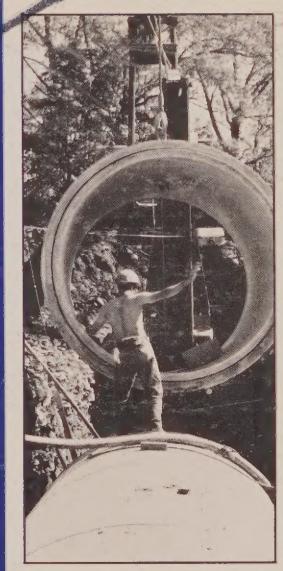


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-73 R23

# Recommended Guidelines for Residential Servicing in Ontario



Ontario  
Housing  
Advisory  
Committee  
Dec. 1973

*[Handwritten signatures and initials are present at the bottom right, including "Gordon", "Butler", and "C.J. C."*





O A Z O N  
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ONTARIO  
HOUSING ADVISORY COMMITTEE

Suite 202, 36 Wellesley Street West, Toronto, Ontario • 965-4611

December 20, 1973

Hon. Robert Welch,  
Ministry of Housing,  
Whitney Block, SW 1324,  
Queen's Park,  
Toronto, Ontario.

Dear Mr. Minister:

On behalf of the Ontario Housing Advisory Committee, I am pleased to submit its research report — "Recommended Guidelines for Residential Servicing in Ontario." This report represents more than two years of study to provide the municipalities of Ontario and the housing industry with a design guide for municipal services. It is the hope of this Committee that these recommendations will contribute to more and better housing for the people of this Province.

While the study was initiated by the Ontario Housing Advisory Committee, it had the financial participation of the Housing & Urban Development Association of Canada, the Urban Development Institute, the Association of Professional Engineers of Ontario, as well as the fullest co-operation of many members of these associations.

The Committee acknowledges the contribution to this study by Mr. R. V. Anderson, P.Eng., who produced the initial research paper for consideration by the municipalities, and to Mr. James A. Metcalfe, P.Eng., who completed Phase 2 of the final document.

A Steering Committee maintained a constant vigil over this study and the gratitude of the Ontario Housing Advisory Committee is extended to Mr. R. E. Davey, P.Eng., Mr. Mario Bruno, P.Eng., Mr. John A. Boddy, P.Eng., Mr. E. McCarthy, Mr. Andrezej Derkowsky, M.T.P.I.C., and Mayor Brian Best, P.Eng., for their valuable participation in the report.

It is the hope of our Committee that this report will be of value to the Government of Ontario, to the housing industry, and to the people of the Province.

Yours truly,

A handwritten signature in black ink, appearing to read "P.A. Monaghan".

Patrick A. Monaghan, P.Eng.,  
Chairman.



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# 1

## Summary of Conclusions and Recommendations



# **Summary of Conclusions and Recommendations**

This report, based on over two years of study on residential servicing, presents recommended guidelines on residential servicing standards and practices in Ontario municipalities. Included in the report are roadway and related features, sanitary drainage, storm drainage and water distribution facilities. Other utilities such as power, gas and telephone are included only as they influence road allowance width and other municipally supplied services. Excluded are features of residential servicing not normally contained in the road right-of-way. The report also avoids discussion of many servicing design details, for example, pipe bedding. These were felt to be beyond the scope of this study.

## **1.1 CONCLUSIONS**

1. There appears to be a need for province-wide guidelines and standards for residential servicing. Such guidelines however, should not preclude the setting of or use of local standards where local conditions justify.
  - (i) A safe, clean water supply available at all times on demand;
  - (ii) All weather road access for all vehicles at all times;
  - (iii) Safe, sanitary sewage treatment or disposal;
  - (iv) Protection from house flooding even under severe conditions; and,
  - (v) Other utilities such as electric power, telephone and heat.
2. Certain municipally supplied services appear to be accepted by the general public as essential services. These include:
  - (i) A safe, clean water supply available at all times on demand;
  - (ii) All weather road access for all vehicles at all times;
  - (iii) Safe, sanitary sewage treatment or disposal;
  - (iv) Protection from house flooding even under severe conditions; and,
  - (v) Other utilities such as electric power, telephone and heat.
3. Existing local standards for residential servicing are not readily available within all municipalities, particularly smaller towns and rural townships. As an example, over half of the municipalities surveyed do not have complete standards for services.
4. Existing residential servicing standards in some cases vary widely from municipality to municipality, often simply across municipal boundaries.
5. Development costs in Ontario constitute between 8 and 24 per cent of housing cost depending on land and building cost. For a typical 50 foot wide lot, the average development cost per house in 1972 was approximately \$4,500, ranging from a low of \$3,000 per lot to a high of \$6,000 per lot. Servicing costs approximated 75 per cent of development costs or an average of \$3,600 per lot. Current information indicates that for 1973, development costs per house may be closer to \$6,000. However, the majority of this increase may be attributed to increases in areas other than servicing construction costs.
6. There are a number of potential modifications in servicing standards and practices which could reduce residential servicing costs. By component, cost reductions could be realized as follows if the standards contained in this report were applied.

COST ELEMENT	POSSIBLE COST REDUCTION (%)
— Right-of-way Land Cost	(See Figure 5.4)
— Roadway, Curb and Gutter	up to 15%
— Sidewalks	up to 50%
— Sanitary Sewers	up to 5%
— Storm Sewers	up to 20%
— Water Distribution Facilities	up to 20%
— Service Connections	up to 40%
<b>TOTAL POSSIBLE COST SAVING</b>	<b>up to 20%</b>

7. Standardization could lead to further cost savings due to simplified bid preparation and construction procedures by contractors.
8. Even though excluded from the terms of reference of this report, other considerations such as civic design features, plan approval requirements and municipal levies could play a more important role than servicing in reducing housing costs.

## 1.2 Recommendations

1. That this report be circulated by the Province to all municipalities in Ontario as a guide to adequate residential servicing standards and practices.
2. That existing Provincial policies and standards on residential servicing such as road widths, pipe materials, design procedures, etc. which are in contradiction with this report be reviewed.
3. That greater flexibility be provided in the servicing of residential areas with a view towards allowing new ideas and reducing costs without sacrificing levels of service.
4. That the standards contained within this report be tested in specific applications followed by a monitoring program to verify the suitability of the proposed standards and that the results of this monitoring program be published and circulated by the Province.
5. That government incentive by way of capital and/or maintenance subsidies or grants be made available for the implementation and testing of unproven but promising servicing innovations.
6. That further research as proposed in Section 6.4 be undertaken by the Ontario Housing Advisory Committee or the Province, or both.

# 2

## Introduction



# Introduction

## 2.1 SCOPE AND CONTEXT

Residential servicing in Ontario forms a significant component of housing cost. Standards and levels of service vary widely throughout the Province. Many of these have developed based on historical application or have been adapted from standards set in other municipalities. It was in consideration of this that the Ontario Housing Advisory Committee set out to study municipal servicing standards in Ontario.

To undertake this study, the Municipal Services Steering Committee, a subcommittee of the Ontario Housing Advisory Committee was formed. This Committee expressed the following objective for a study of municipal servicing standards in Ontario:

*"To establish minimum acceptable guidelines for residential servicing in Ontario considering both initial capital costs and continuing operations and maintenance costs".*

The Committee recognized that many factors were contributory to housing cost including the supply and cost of money, the cost of raw land, the cost and availability of trunk services, the cost of house construction and administration costs. It also recognized that many planning considerations such as lot size, lot shape, lot grouping and setback requirements can contribute substantially to the cost of housing. Nevertheless, the Committee concluded that there was a definite need to review and set guidelines for residential servicing practices in Ontario. The work of the Committee was strictly limited to municipally supplied services contained within the road right-of-way; namely roadway, sidewalks, sanitary and storm sewers and water distribution facilities. Other utilities such as power, gas and telephone were considered only from the standpoint of their influence on right-of-way widths and the location of other services within the road allowance.

## 2.2 STUDY METHODOLOGY

The study of residential servicing in Ontario was carried out in three phases:

1971 – August, 1972	i) Background and research culminating in the report "Research Report on Municipal Services for Residential Subdivisions, August 1972", R. V. Anderson.
August, 1972 – March, 1973	ii) Province-wide circulation of the "Research Report" to over 80 federal, provincial and private agencies and organizations and receipt of comments.
March, 1973 – September, 1973	iii) Review of the Research Report and of the comments received on that report by five specialist consultants in the fields of traffic, sanitary and storm drainage and water distribution; and two one-day round table seminars with representatives of various organizations in Ontario concerned with the planning, design, construction and maintenance of residential services.

This report presents a summary of recommended guidelines for residential servicing based upon the above. A Technical Appendix to this report together with the 1972 "Research Report" provides the back-up for the recommendations presented.



# 3

## Current Servicing Standards and Practices



# Current Servicing Standards and Practices

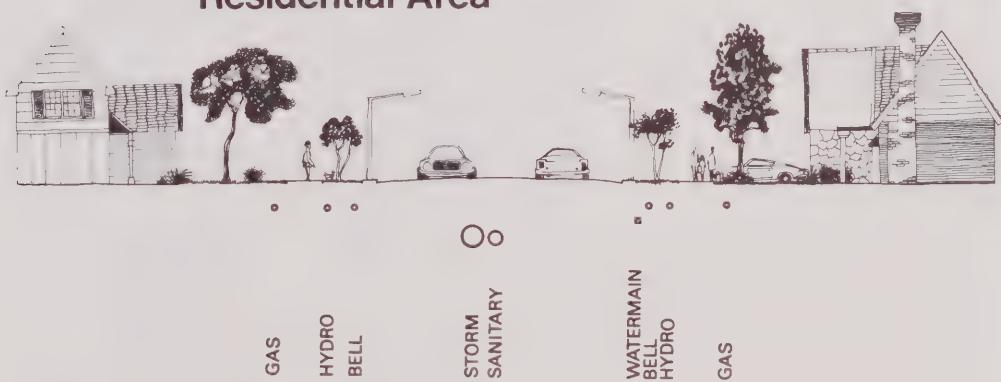
## 3.1 SERVICING REGULATIONS

The essential services of roads, water, sewers, power and telephone, today are expected as a necessary part of residential development. These services are planned, designed and constructed in most cases at the developer's or builder's cost, a cost which is passed on to the home purchaser as a part of his overall house cost.

The services provided and the standards to which they are built are regulated by the municipal government or utility authority within the area where the development takes place. The Province, although not directly involved in the setting of standards, does impose certain controls. For example, the Ministry of Transportation and Communications requires that pavement widths be a minimum of 28 feet if future road reconstruction subsidy is to be granted. The Ministry of Natural Resources imposes design storm criteria for the design of storm drainage works for major watersheds. The Ministry of the Environment in certain instances specifies pipe sizes and design criteria. However, even with these and other Provincial regulations, residential servicing standards are generally a local decision.

Most urban municipalities today have standards for at least some of the necessary residential services. However, it is apparent that not all have complete standards and that many smaller rural municipalities have almost no standards for urban type services.

**Figure 3·1 Typical Services and Utilities in a Residential Area**



## 3.2 EXISTING STANDARDS AND PRACTICES

Existing servicing standards and practices today vary widely across the Province. Standards are essentially the responsibility of the Regional or local municipality. Many requirements have evolved over time based on past experience. Others have been borrowed from other municipalities and applied to local conditions. Certain standards have been developed by the Roads and Transportation Association of Canada, the Municipal Engineers Association, the Ministry of Transportation and Communications, Ontario, the Ministry of the Environment and the Ministry of Natural Resources. However, most of these standards apply only to the major trunk facilities or very large areas. Very little is available in the way of national or provincial guidelines for the design of local streets and services in residential areas.

Local municipal standards for residential servicing also are not always readily available, particularly in smaller municipalities. In a 1972 survey of 60 municipalities, less than half could provide complete standards. Tables 3.1 and 3.2 present reported design standards for those municipalities which responded. Standards are presented as lowest, median or most often used and highest.

**TABLE 3.1 SUMMARY OF EXISTING RESIDENTIAL SERVICING STANDARDS IN ONTARIO (ROADS)**

	Highest Standard	Median or Standard (Local Roads)	Lowest Standard	Highest Standard	Median or Standard (Collectors)	Lowest Standard
<b>ROAD GEOMETRICS</b>						
Design speed (m.p.h.)		30		40	35	30
Maximum degree of curve	30°	N.A.	N.A.	13°	21°	30°
Minimum centreline radius (ft.)	230	N.A.	N.A.	441	272	191
Minimum safe stopping distance (ft.)	300	200	100	275	200	175
Minimum visibility curve (ft.)	—	—	—	450	310	275
Minimum grade (%)	0.6	0.5	0.3	0.6	0.5	0.3
Maximum grade (%)	10.0	8.0	5.0	10.0	8.0	5.0
Minimum cross slope (%)	3.0	2.5	1.67	3.0	2.0	1.5
Maximum cross slope (%)	3.0	2.5	2.0	3.0	2.0	2.0
Minimum right-of-way width (ft.)	66	66	60	86	76	66
Maximum right-of-way width (ft.)	—	—	—	100	86	66
Pavement width - urban section (ft.)	32	28	21	48	36	28
- rural section (ft.)	24	22	20		36	
Boulevard width (ft.)	19	11	8	18	14	8
Boulevard slope (%)	10.0	2.0	1.0	10.0	2.0	1.0
Sidewalks (sides)	2	2	1	2	2	1
Outer separation (ft.)	6	3	1	3.5	3	1
Minimum tangent between curves (ft.)	150	150	N.A.	250	150	150
Minimum tangent at intersection (ft.)	—	—	—		150	
Asphalt depth (inch)	3	3	2	8	3	3
Concrete depth (inch)	—	—	—		7	
Granular depth (inch)	21	12	8	23	12	3
Illumination location (sides)	2	1	1	2	1	1
Illumination distance from streetline (ft.)	15	11	9.5	18	10.5	9.5
<b>CURB AND CURB AND GUTTER</b>						
Base width (inch)	11	9	6	27	20	19
Back height (inch)	24	18	14	16	14	12
Concrete strength (psi)	4000	4000	3500	4000	3500	3000
Driveway mounting height (inch)	1 1/4	1	1/2	2	1	0
Driveway cut depth (inch)	4 1/2	4	2 3/4	4	3 1/2	2

TABLE 3.1 (Continued)

	Highest Standard	Median or Most Used Standard	Lowest Standard
<b>INTERSECTION CURB RADII (ft.)</b>			
Local - local	30	25	17
Local - collector	35	30	17
Local - arterial	35	35	25
Collector - collector	55	30	17
Collector - arterial	50	30	30
Arterial - arterial	55	55	35
<b>CUL-DE-SACS (ft.)</b>			
Local - minimum curb radius	56	40	25
- minimum ROW radius	75	57	50
Collector			
- minimum curb radius	55	45	40
- minimum ROW radius	60	58	58
<b>UTILITY LOCATIONS</b> - distances from streetline (ft.)			
Gas line location	14	3	2
depth	4	3	2
Bell cable location	27	11.5	0
depth	3	2	1.5
pole location	14	10	8
Hydro cable location	15	8.5	0
depth	3	2	2
pole location	13	10	8
<b>SIDEWALKS</b>			
Width (ft.)	5	5	4
Normal thickness (inch)	6	5	4
Thickness at driveways (inch)	8	7	5
Minimum cross slope (%)	3	2	2
Maximum cross slope (%)	6	2	2
Concrete strength (psi)	4200	4000	3000
Granular bedding depth (inch)	7	5	0
Distance from streetline (ft.)	6	3	1
<b>WALKWAYS</b>			
Right-of-way width (ft.)	10	10	5
Pavement width (ft.)	10	5	4
Pavement thickness		6" concrete or 2" asphalt	
Cross slope (%)	6	2	2
Minimum grade (%)		0.5	
Maximum grade (%)	10	6	6
<b>BOULEVARDS</b>			
Minimum width (ft.)	11	10	5.5
Maximum width (ft.)	19	14	10
Minimum cross slope (%)	2	2	1
Maximum cross slope (%)	10	4	2
Topsoil thickness (inch)	4	4	3

**TABLE 3.2 SUMMARY OF EXISTING RESIDENTIAL SERVICING STANDARDS IN ONTARIO (UNDERGROUND SERVICES)**

	Highest Standard	Median or Most Used Standard	Lowest Standard
<b>STORM DRAINAGE</b>			
Runoff Coefficients			
Single family residential	0.60	0.40	0.20
Semi-detached residential	0.60	0.40	0.20
Townhousing	0.75	0.60	0.40
Apartments	0.90	0.70	0.40
Schools	0.75	0.75	0.40
Churches	0.75	0.75	0.40
Industrial	0.90	0.75	0.40
Commercial	0.90	0.75	0.50
Downtown commercial and heavy equipment	0.95	0.90	0.60
Parkland	0.30	0.20	0.10
Asphalt, concrete, roofs	1.00	0.90	0.85
Grassed areas	0.20	0.20	0.15
Bare soil	0.70	0.20	0.10
<b>Open Channel Flow</b>			
Minimum flow velocity (fps)		2.5	
Maximum flow velocity (fps)		5.0	
Design storm (yrs.)		25	
<b>Sewers</b>			
Minimum radial pipe diameter (inch)	33	—	30
Minimum entry time (min.)	20	15	5
Design storm (yrs.)	10	5	2
<b>Culverts</b>			
Design storm (yrs.)	25	25	10
<b>Catchbasins</b>			
Spacing (ft.)	350	—	150
Minimum single CB lead size (inch)	12	10	6
Minimum double CB lead size (inch)	12	10	9
<b>SANITARY SEWERAGE</b>			
<b>Unit Flow Rates</b>			
Per capita flow rate (gcd)	125	100	80
Single family residential (ppa)	40	25	15
Multi-family residential (ppa)	90	55	15
Apartments (ppa)	7000	135	45
Commercial (ppa)	160	55	20
Industrial (ppa)	85	45	15
Schools (ppa)	95	95	35
Institutional (ppa)	60	—	25
<b>ROUGHNESS COEFFICIENTS</b>			
Concrete pipe	0.015	0.013	0.011
Vitrified clay pipe	0.013	0.013	0.010
Asbestos cement pipe	0.013	0.013	0.010
Plain CSP	0.033	0.025	0.024
CSP - asphalt coated, paved invert	0.026	0.020	0.017
CSP - smooth asphalt coat	0.022	0.015	0.011
Concrete box culvert	0.013	0.013	0.010

Manning formula used for gravity flow calculations

TABLE 3.2 (Continued)

	Highest Standard	Median or Most Used Standard (Sanitary)	Lowest Standard	Highest Standard	Median or Most Used Standard (Storm)	Lowest Standard
<b>SANITARY AND STORM FACILITIES</b>						
<b>Sewers</b>						
Minimum pipe diameter (inch)	10	10	8	15	12	10
Minimum flow velocity (fps)	2.5	2.5	2.0	3.0	2.5	2.0
Maximum flow velocity (fps)	15	10	8	20.0	12.0	10.0
Minimum slope (%)	0.8	0.4	0.3			
Minimum depth of cover (ft.)	10	9	3.5	9	5	3.5
Location-distance from centreline (ft.)	20	5	0	19	6	5
<b>Manholes</b>						
Minimum size - poured (ft.)	4 x 4	4 x 4	2.5 x 4	4 x 4	4 x 4	2.5 x 4
- precast (inch)	48	48	42	48	48	42
Manhole spacing (ft.)	600	350	300	500	300	300
Drops - less than 45° bend (ft.)	0.25	0.15	0.05	0.25	0.25	0.10
- greater than 45° bend (ft.)	0.50	0.50	0.25	0.50	0.50	0.25
<b>House Connections</b>						
Minimum pipe size (inch)	6	5	4	6	5	4
Minimum depth of cover (ft.)	9	7.5	3.0	8.0	7.5	7.5
Location - distance from lot centreline (ft.)	10	—	0	10	—	0
Minimum slope (%)	2	2	1	2	1	1
<b>WATER DISTRIBUTION FACILITIES</b>						
Minimum diameter main to a hydrant (inch)			6			
Minimum diameter main (inch)	6	6	2			
Hydrants with valves used		Yes				
Hydrants without valves used		Yes				
Maximum diameter of main for hydrant without valves (inch)	12	10	8			
Hydrant spacing (ft.)	1000	400	350			
Minimum valve size for valve chamber (inch)	16	10	6			
Minimum diameter of valve chamber (inch)	48	48	42			
Valve spacing (ft.)	1600	—	1000			
Number of valves at Tee-intersection			2			
Number of valves at Cross-intersection	4	—	3			
Minimum watermain cover (ft.)	7	5.5	5			
Maximum watermain cover (ft.)	9	6.5	6			
House service size (inch)	3/4	3/4	5/8			
House service depth of cover (ft.)	7	5.5	5.5			
Per capita flow rate (See also sanitary sewerage flows) (gpd)	125	100	100			

### 3.3 SERVICING INNOVATIONS

Recommended standards presented in this report are based on currently available and widely used methods, materials and techniques. However, in establishing standards, it must be pointed out that new methods will continuously become available which will change servicing requirements. The topic of innovation in servicing is beyond the Terms of Reference of this study. However, a complete review of the "state of the art" and innovative technology is being conducted in conjunction with the planning of the North Pickering Community for the Ministry of Treasury, Economics and Intergovernmental Affairs. The results of this review should be available early in 1974.

In summary, some of the innovative concepts that are already developed to the stage of feasibility which may contribute to improved servicing and reduced costs include:

- (i) Complete computer design of services using co-ordinate controlled data for horizontal and vertical location plus the desired design parameters. Such designs can be printed out on plan form by the computer and also stored for instant recall by future system operators.
- (ii) The use of sophisticated theories and modelling techniques is now possible via computer. The results can be a more accurate design which is neither underdesigned and thus costly to correct or over-designed and wasteful.
- (iii) The availability of a wide range of plastics for uses such as sewers, water mains, gas mains, and hydro and telephone conduits. Plastics can provide for easy installation, good service characteristics and long life.
- (iv) Precast or factory made components such as manholes and catchbasins, pumping stations, and curbs all can contribute to better quality and greater economy.
- (v) New equipment has made possible the installation of pipes without opening a trench. Machines are available to "plough-in" pipes beneath the ground.
- (vi) Alternate materials are being investigated to improve the durability of road surfaces. Such materials as glass and asbestos have been used.

# 4

## Recommended Practices and Standards



# Recommended Practices and Standards

## 4.1 BASIS OF RECOMMENDATIONS

The recommended guidelines for residential servicing are considered to be the minimum necessary to maintain an adequate level of service to residents considering safety, health and today's life style. It is recognized that in certain instances, higher standards may be desirable. The guidelines presented should in no case preclude these higher standards where they are warranted to satisfy civic design or local objectives. The recommended guidelines also apply to typical provincial conditions. Where extremes such as in climate, topography and geology are encountered, variations may be justified.

## 4.2 ROADS AND RELATED FEATURES

### 4.2.1 Street Classification

Residential street standards should be in accordance with the street function or "classification". Three residential street classifications are recommended; minor local, local, and, collector. Selection of the appropriate classification and thus the standards should be based on the traffic volume and on the number of houses with access onto the street as follows:

**Figure 4·1 Street Classification**



**TABLE 4.1 – RECOMMENDED STREET CLASSIFICATION  
BY TRAFFIC VOLUME AND HOUSING DENSITY**

Street Classification	Auto Oriented No. of Houses	Transit Oriented* No. of Houses	Estimated Daily** Traffic Volume (A.A.D.T.)
Minor local	up to 25	up to 30	0 – 250
Local	up to 100	up to 125	0 – 1000
Collector	101 – up	126 – up	1000 – 3000

\* Transit oriented is defined as homes within 1,000 feet of a transit service with a frequency of service of not more than 30 minutes.

\*\* Traffic volumes are based on trips per household as follows:

Single family	— 8-10 per day
Multiple family	— 7-9 per day
Apartment	— 6-8 per day

Streets with volumes in excess of 3,000 average annual daily traffic (A.A.D.T.) should be considered as major collectors or arterials and should conform to the recommended standards for arterial and collector roads published by the local municipality or as recommended in the manual "Geometric Design for Ontario Highways and Streets", Ministry of Transportation and Communications, Ontario.

#### 4.2.2 Road Allowance Width

The width of road allowance in a residential subdivision should be adequate for the construction, placement, maintenance and repair of all necessary services and utilities. The width also should be a function of street classification. Recommended minimum widths are contained in Table 4.2.

**TABLE 4.2 – RECOMMENDED MINIMUM ROAD ALLOWANCE  
WIDTHS FOR RESIDENTIAL STREETS**

Street Classification	Minimum Width of Road Allowance
Minor locals	56 feet
Locals	60 feet
2-lane collectors	70 feet
4-lane collectors	80 feet

The minimum widths require location of sanitary and storm sewers and possibly water mains within the pavement area. Surface feature dimensions are shown in Tables 4.3 and 4.4. In selecting the recommended minimum road allowance widths, the Committee considered only the needs within the road allowance; a review of housing setback requirements was not considered.

The above minimums are based on the assumption that all services are contained within the road allowance. These minimums also provide for utility requirements as they now exist. In cases where utility easements are considered, where utility space requirements can be reduced or where all utilities are not provided, a lesser width may be adequate.

#### **4.2.3 Planning Standards and Practices**

The residential planning process involves the consideration of social, physical and environmental factors of land use planning and community design. Streets form the skeleton of any community plan. Among the many factors to be considered in street planning are the following:

1. Residential streets should conform to the community design objectives and wherever possible, should not dictate the nature of the community housing patterns.
2. Local street patterns should be planned to minimize through traffic.
3. Local street patterns and intersections should conform to bordering arterial routes and should not detract from their efficiency.
4. Local street plans should not be reliant upon traffic regulatory devices for efficient, safe operations.
5. Space devoted to residential streets should be kept to a minimum.
6. The number of street intersections should be kept to a minimum. Tee-intersections are preferred to cross-intersections.
7. Local street patterns as much as possible should relate to the natural topography of the land.
8. Single family dwellings having individual direct access to streets other than minor locals, locals and collectors, as defined, should be avoided.
9. On residential streets where fixed route public transit services are to be operated, street facilities and dimensions should be designed to collector standards, with consideration of and provision for bus stopping, turning, loading and unloading.
10. The street system should clearly indicate the characteristic and nature of the street function as local, collector or arterial.

#### **4.2.4 Geometric Road Standards for Urbanized Areas**

1. Streets with curbs and storm sewers are recommended for urbanized areas. Only where specific research indicates an overall cost advantage for ditch drainage, where special civic design effects are to be achieved or where lot frontages are generally greater than 100 feet, should open ditch drainage and the exclusion of curbs and storm sewers be acceptable.
2. All streets should be designed according to their functional classification. Recommended minimum design criteria for residential streets, are shown in Table 4.3.

**TABLE 4.3 – RECOMMENDED RESIDENTIAL STREET DESIGN STANDARDS**

	Minor Local	Local	Collector 2-lane & 4 lane
<b>Classification Criteria</b>			
No. of Units	up to 25	up to 100	100 up
Traffic Volume (AADT)	up to 250	up to 1000	1000-3000
Design Speed (mph)	25	25	30
<b>Cross Section Features</b>			
Minimum Pavement Width (face-to-face of curb) (ft)			
– no parking	18(1)	26	32(4)
– parking one or both sides	24(1)	26	42(5)
– traffic lanes (ft)	8	9	11
– parking lanes (ft)	8	8	10
Minimum Boulevard Width (ft)	8	8	10
Sidewalk Location	Not Req'd(2)	One Side Only(2)	According to Warrants Table 4.5
Minimum Sidewalk Width (ft)	4	4	5
Outer Separation Width (ft)	3	3	3
Minimum Right-of-Way Width (ft)	56(3)	60(3)	70 and 80
<b>Geometric Features</b>			
Min. Centreline Radius (ft)	200(6)	200(6)	275
Min. S.S.S.D. (ft)	100	150	200
K – Crest	8	16	28
K – Sag	12	24	35
Percent Grade – Minimum	0.5	0.5	0.5
– Maximum	12	8	8
Min. Cul-de-sac Pavement Radius (ft)	35	35	45
Min. Cul-de-sac Radius at Property Line (ft)	50	50	60
Intersection Radius		(See Table 4.4)	
Curb & Gutter Type – B = Barrier R = Rolled	R	R	B
Lighting: Maintained Intensity in foot – candles	0.2	0.2	0.6

Notes: (1) Sufficient off-street parking is required for occupants as well as the majority of visitors, or a minimum of at least 2 spaces/unit. Parking restrictions on one side may be required on curves or where adequate off-street parking is not available.

(2) Sidewalks may be required on one or both sides if the street forms a walkway to schools, shopping, parks, etc.

(3) Allowance is made for possible future sidewalk.

(4) Parking restricted to one side only.

- (5) No parking restriction.
- (6) Except at 90° corners for crescents.

**TABLE 4.4 – RECOMMENDED INTERSECTION CURB RADII**

Street to Street	Radius (ft)
Minor local to minor local	25
Local to local	25
Minor local or local to collector	30
Minor local or local to arterial	35
Collector to collector	30
Collector to arterial	35

#### 4.2.5 Sidewalks

Where analysis of the need for sidewalks is required, they should be provided on local and collector streets according to the following warrants:

**TABLE 4.5 – WARRANTS FOR THE PROVISION OF SIDEWALKS**

Warrant	Vehicles Per Day	Pedestrians Per Day
S/W Required One Side	250 – 1000	150
	1000 up	100
S/W Required Both Sides	500 – 1000	500
	1000 up	300

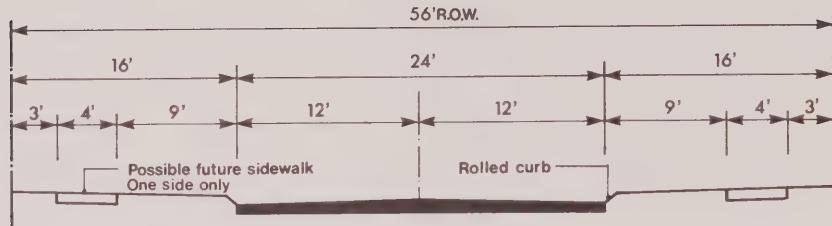
Sidewalks are warranted on minor locals only when the route forms part of a pathway to schools or other activity centres. Minimum sidewalk widths should be not less than four feet. Where local policy includes municipal sidewalk snow removal, a minimum width of five feet is recommended based on presently available equipment. Sidewalks and curbs should be depressed at street intersections to permit easy passage of vehicles, such as carriages and wheelchairs.

#### 4.2.6 Pavement Standards

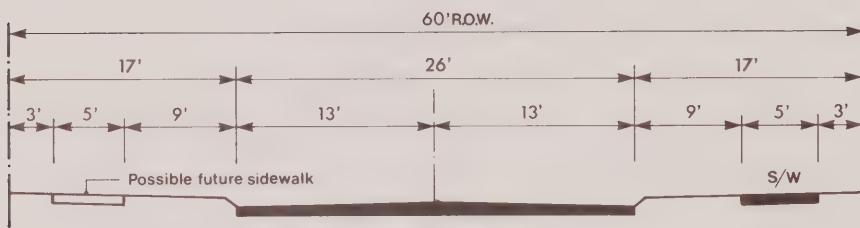
Pavement design should be based on traffic loading, traffic volume, soil conditions and the type of road construction materials available.

2. Where there is question as to the applicability of municipal pavement design standards under local soil conditions, soil testing and a specific pavement design are recommended.
3. The selection of a flexible pavement or rigid pavement should be based on local conditions and the availability of pavement construction materials.
4. If municipal pavement design standards are not available, or if the design is to be based on local soil tests, flexible pavements should be designed according to the "Equivalent Thickness Method of Flexible Pavement Design" of the Asphalt Institute. Rigid pavements should be designed according to Portland Cement Association standards and recommended design practices.

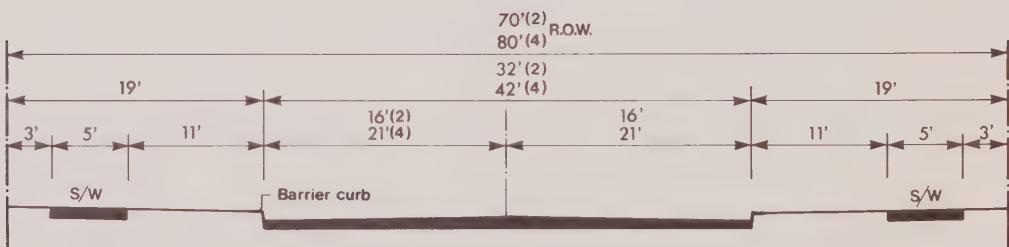
## Figure 4·2 Typical Residential Road Cross Sections



Minor Local



Local

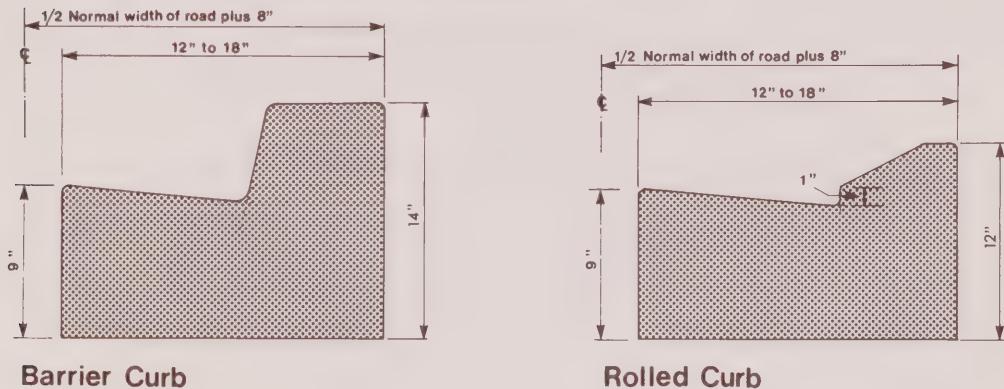


2-Lane and 4-Lane Collector

#### 4.2.7 Curbs and Curb and Gutter

Curb and gutter is recommended for residential streets. For minor local and local roads, a rolled type curb, Figure 4.3 is recommended. For collector streets, a barrier type curb, Figure 4.3 is recommended. Continuous steel reinforcing is recommended when curb and gutter construction precedes house construction. Precast curb and gutter may be used as an alternative to poured-in-place curb and gutter.

**Figure 4-3 Recommended Curb and Gutter for Residential Streets**



#### 4.2.8 Material Standards

Construction material specifications should be in accordance with Ministry of Transportation and Communications, Ontario specifications as follows: Granular Materials, Form 314; Asphalt Pavement, Form 310; Concrete Pavement, Form 313; Concrete for Curbs, Sidewalks, etc., Form 9.

#### 4.2.9 Compaction Standards

1. Earth and natural materials forming the road subgrade and service trench backfill should be compacted to 95 per cent Standard Proctor Density.
2. Granular materials either in service trenches or in base course construction should be compacted to 100 per cent Standard Proctor Density.

### 4.3 STORM DRAINAGE

#### 4.3.1 Storm Water Flow Calculation

1. Where applicable, the Environment Canada, Atmospheric Environment Service rainfall intensity-duration-frequency curves should be used for estimating rainfall intensity values. If the Environment Canada curves do not apply, the "local" curves should be checked against the curves provided in the publication "Climatological Studies No. 8" published by the Atmospheric Environment Service.

- The Rational Method should be used for computing storm water run-off quantities for the local system in residential subdivisions. When the drainage catchment area is large and under the jurisdiction of the Conservation Authorities Branch of the Ministry of Natural Resources, that Authority determines the design flood and storm run-off quantities.
- Average run-off coefficients for all classes of land use should be computed on the basis of the ratios of areas of the various types of surfaces in accordance with Table 4.6.

**TABLE 4.6 – RECOMMENDED RUN-OFF COEFFICIENTS FOR CALCULATING STORM WATER FLOW**

Surface Type	Recommended Run-off Coefficient
Asphalt, Concrete, Roof Areas and Impervious Areas	0.95
Sodded Open Areas with,	
Sandy Soil – 0-2% ground slope (flat)	0.15
– 2-7% ground slope (rolling)	0.20
– over 7% ground slope (steep)	0.25
Sodded Open Areas with,	
Clayey Soil	
– 0-2% ground slope (flat)	0.20
– 2-7% ground slope (rolling)	0.25
– over 7% ground slope (steep)	0.30

#### 4.3.2 Storm Sewer Design Practices

- Design Storm Selection – Storm sewers on residential streets should be designed to accommodate a storm with a return period of two years provided weeping tiles are not affected and roads are properly designed as drains. Storm sewers should be designed to ensure that basements are not subject to flooding, even during severe storm conditions. The determination of these severe conditions should be a local decision. However, a 25 year storm is suggested as a guide.

Where weeping tiles are connected to the storm sewer and where analysis indicates that surcharging could occur with a two year design storm, then the pipe capacity should be increased to ensure that flooding would not occur under these severe storm conditions.

- Surface Drainage – where practical, considering topography and economics, roadway grades and lot drainage should be designed with continuous fall to a storm drainage outlet, to serve as surface drainage channels during peak storm conditions.
- Design Capacities – The capacity of storm sewers should be calculated using Manning's, Kutter's or Hazen-Williams' formula. (See Section 8)
- Curvilinear Storm Sewers – Curvilinear storm sewers should be considered where economies or design improvements can be achieved. Maximum curvature should be limited to connection tolerances specified by pipe manufacturers.
- Pressure Pipes – where required, sewers may be designed as pressure pipes providing that weeping tiles are not affected.

6. Foundation Weeping Tiles — Foundation weeping tiles should be discharged onto the surface or into the storm system. Weeping tile drainage should be by one of the following means:
  - (i) by sump pumps discharged to the ground surface; or,
  - (ii) by connection to the storm sewers with flow either by gravity or sump pump. Connections of weeping tiles to storm sewers should be permitted only where surcharging would not occur even during severe storm conditions as previously outlined.

Under appropriate ground conditions where flow into the weeping tile system is minimal throughout the year, foundation weeping tiles could be connected to sanitary sewers.

7. Roof Drainage — Roof drainage downspouts should be discharged onto the ground surface and directed away from foundations when weeping tiles are not connected by gravity to storm sewers. When weeping tiles are connected by gravity, downspouts could be connected to the same system.
8. Combined Connections to Storm Sewers — Where weeping tile connections to storm sewers are provided, two lots may be served by a common pipe from the sewer to the street line providing the street gradient across the property frontage is not greater than three per cent.
9. Site Grading — General site grading should conform to the existing topography as much as possible. Where practical, the street pattern should be designed to permit continuous drainage to open watercourses in order to protect private property during severe storm conditions or storm drainage blockages:
10. Lot Grading — Lots should be graded to direct water away from foundations. Lot grading where possible should conform to the existing drainage patterns. The use of rear lot drainage catchbasins should be limited as much as possible. On lots with rear lot catchbasins, access and working easements should be granted to the municipality.

Legal stipulations should be placed on the title of individual properties restricting changes to lot grading and drainage.

11. Storm Water Retention Ponds — Where applicable, consideration could be given to the creation of small storage lakes in association with parks for the purpose of reducing peak storm flows.
12. Storm Sewer Service Trenches — Storm sewer service trenches should be backfilled with selected native material.

#### 4.3.3. Storm Sewer Design Standards

1. Design flow velocities in storm sewers should not be less than 2.5 fps nor greater than 20 fps. Velocities at pipe outlets should be controlled to prevent erosion of the receiving channels.
2. The minimum allowable pipe size for storm sewers should be 10 inch diameter (dia.)
3. The minimum depth of cover to the top of a storm sewer should be four feet or to frost penetration, whichever is greater. For large sewers, say 54 inch diameter and greater, the minimum depth of cover may be set to ensure that frost penetration does not pass below the sewer spring-line.

4. The maximum distance between manholes should not exceed 550 feet.
5. The minimum inside dimension (ID) of manholes should be the sewer pipe ID plus 18 inches for straight runs or bends up to 30 degrees or the sewer pipe ID plus 24 inches for junction manholes or bends greater than 30 degrees. In no case should the minimum inside dimension be less than 48 inches.
6. Differences in elevation across manholes should be provided to account for hydraulic losses as calculated using the formula in Section 7, or, where the velocity change is less than two fps across the manhole, as follows:
 

0° – 10° Change in Direction	– 0.05' difference
10° – 45° Change in Direction	– 0.15' difference
45° – 90° Change in Direction	– 0.25' difference
90° or greater	– 0.50' difference

7. Where storm sewer house connections are provided, the minimum pipe size should be six inches for combined connections and five inches for single connections.

#### 4.3.4 Storm Sewer Location

Storm sewers should be located under the curb for shallow storm systems or near the centreline of the roadway where the depth to the top of the pipe exceeds six feet. Catch-basin manholes may be used for shallow sewers under the curb where manholes are required.

#### 4.3.5 Catchbasins

1. Catchbasins are required at all low points in the road and at low grade points at intersections. Additional catchbasins should be provided along the roadway as set out in Table 4.7.

**TABLE 4.7 – MAXIMUM SPACING OF CATCHBASINS**

Road Grade (%)	Maximum Spacing
0.5 – 3.0	350 feet
3.0 – 4.5	300 feet
greater than 4.5	250 feet

\*The maximum distances are based on the capacity of a 24 inch... square grate on pavement widths up to 32 feet.

2. Double catchbasins or special catchbasins are recommended where the inlet capacity of a single catchbasin is exceeded.
3. Use of the “bicycle proof” catchbasin covers should be considered for all streets.

#### 4.3.6 Storm Sewer Pipe Material

1. Storm sewer pipe of the following materials are acceptable and should be manufactured to the following specifications:\*

Concrete Pipe:	ASTM C14 or C76 (under review)
Asbestos Cement Pipe:	ASTM C428
Vitrified Clay Pipe:	CSA A60.1 or A60.3
Polyvinylchloride Pipe:	CSA B137.3 or ASTM D2729
Corrugated Steel Pipe:	CSPI 501-70

2. All storm sewers should be installed with watertight joints.

#### 4.4 SANITARY DRAINAGE

##### 4.4.1 Sanitary Sewage Flow Calculations

Sanitary sewers should be designed for peak flow plus an allowance for infiltration. Peak flows should be estimated using either the Babbitt or Harmon formula which are based on average daily water consumption, recommended in this report as 80 — 100 gallons per capita per day.

For sanitary sewers installed above the ground water table, infiltration allowance should be 0.0001 cfs/acre. For sanitary sewers installed below the ground water table, the infiltration allowance should be higher in accordance with analysis of local conditions.

##### 4.4.2 Sanitary Sewer Design Practices

1. Manning's, Kutter's or Hazen-Williams' formula should be used for computing the capacity of sanitary sewers (See Section 8).
2. Sanitary sewers may be designed as pressure pipes provided that the hydraulic gradient for maximum flow is below basement elevations.
3. Weeping tiles should not be connected to the sanitary system where moderate to high infiltration is expected.
4. Straight sewers are recommended for sanitary sewers. Where hydraulic cleaning equipment is available, curvilinear sewers may be considered for pipe sizes in excess of 12 inches in diameter.
5. Two lots may be served by a common connection from the sewer to the streetline, providing that the street gradient across the frontage is not greater than three per cent.
6. Sanitary sewer service trenches should be backfilled with selected native material.

##### 4.4.3 Sanitary Sewer Design Standards

1. Sanitary sewer flow velocities should not be less than two fps at full flow nor greater than 15 fps at full flow.
2. The minimum acceptable pipe size for sanitary sewers should be eight inch diameter.
3. The minimum depth of cover should be a function of the proposed basement elevations and sufficient to avoid conflict with other underground utilities. It should never be less than the depth of frost penetration.
4. The distance between manholes should not exceed 550 feet.

5. The minimum inside dimension (ID) of sanitary manholes should be the sewer pipe ID plus 18 inches for straight runs or bends up to 30° or the sewer ID plus 24 inches for junction manholes or bends greater than 30°. In no case should the minimum dimension be less than 48 inches.
6. Elevation Changes in Manholes — See Storm Section 4.3.3.
7. House Connections — Pipe with watertight and rootproof joints should be used for house connections. Minimum pipe size should be six inch diameter for double connections and five inch diameter for single connections.

#### **4.4.4 Sanitary Sewer Location**

Sanitary sewers should be located at or near the centreline of the roadway. Where storm and sanitary sewers are at approximately the same location and depth, and where economies can be achieved, both should be located in the same trench.

#### **4.4.5 Sanitary Sewer Pipe Materials**

1. Sanitary sewer pipe should be of one of the following types and should be manufactured to the following specifications:

Concrete Pipe:	ASTM C14 or C76 (under review)
Asbestos Cement Pipe:	ASTM C428
Vitrified Clay Pipe:	CSA A60.1 or A60.3
Polyvinylchloride Pipe:	CSA B137.3 or ASTM D2729

2. All sanitary sewers should have watertight joints.

### **4.5 WATER DISTRIBUTION**

#### **4.5.1 Calculation of Water Demand**

1. Domestic Water Demand — Domestic water demand varies from location to location depending on life style, housing mix, household income, etc. Where historic information is available on local demand, it should be used to project demand for new areas. Where local information is not available, the following should be used as a guide:
  - Average Daily Demand: 80 – 100 gal./capita/day
  - Peak Daily Demand Factor: 1.2 to 2.0: Avg. = 1.5
  - Peak Daily Demand: 150 gal./capita/day
  - Peak Hourly Demand Factor Expressed as a Daily Rate: 2.0 to 3.0: Avg. 2.5
  - Peak Hourly Demand Expressed as a Daily Rate: 250 gal./capita/day
2. Fire Demand — Fire demand today is normally calculated according to the published requirements of the Canadian Underwriters Association. In summary, these requirements are:
  - minimum flow at a hydrant: = 420 gal/minute (C.U.A. rated hydrant capacity is 500 gal/min.) with a residual pressure of 20 psi;

However, as indicated in Section 6.4 further research on this requirement is recommended.
3. The demand used for main size selection should equal the Fire Flow Demand plus the Peak Daily Demand, or the Domestic Peak Hour Demand whichever is greater.

#### **4.5.2 Water Main Design Practices and Standards**

1. The Hazen-Williams formula is recommended for computing the required size of water mains. (See Section 8).
2. A hydraulic network analysis of a water distribution system should be carried out if demand flow rates will exceed the capacities of minimum specified main sizes. Hydraulic analysis should include allowances for demands of adjacent areas anticipated to be met by transmission through the design area.
3. Dead end mains, except for short sections, should be avoided where practical.
4. Water mains should be located at least three feet behind the curb or, where economies can be achieved in construction or road allowance width, water mains should be located within the roadway under the pavement. In all cases water mains should be located at least one foot clear horizontally and one and one half feet vertically from another utility.
5. Two lots may be served by a common connection from the main to the street line with individual connections from the street line to the house. The individual services should have a minimum of  $\frac{3}{4}$  inches inside diameter; the common connection should have a minimum inside diameter of one inch.
6. Prior to final testing and disinfection, all new works should be thoroughly flushed. The operation of charging and flushing the water mains must be carefully controlled to prevent damage to the pipe, fittings, joints, etc.

Hydrostatic testing and disinfection of water distribution systems should be carried out in accordance with the requirements of A.W.W.A. standards.

7. The minimum allowable size of water mains should be six inches in diameter except as follows:
  - (i) On cul-de-sacs beyond the last hydrant, provided the distance to the nearest hydrant is not greater than 500 feet. In this case, two to four inch diameter main would be acceptable.
  - (ii) On cul-de-sacs to the last hydrant, provided the distance from the larger main to the hydrant is not greater than 200 feet. In this case, a four inch diameter main would be acceptable.
8. The minimum depth of cover to water mains should not be less than the depth of frost penetration. In no case should the depth be less than five feet, with the depth being measured to the top of the main or the house connection gooseneck, whichever is less.
9. All bends, tees and plugged ends should be anchored or blocked.

#### **4.5.3 Valve Design Practices and Standards**

1. Normally, at four-way intersections, at least three valves should be provided and at three-way intersections, at least two valves should be provided. The distances between valves in any given pipe line should be a function of the number of homes that would be inconvenienced by having the water service interrupted. Typically a value of 40 homes is considered to be an acceptable maximum.

2. Valves at street intersections should be located 10 feet behind the streetlines of the intersecting streets.
3. All valves up to and including 10 inches in diameter should be provided with a valve box. For valves 12 inches or greater in diameter, a cast-in-place or precast concrete valve chamber with a drainage sump should be provided. All valves 12 inches or greater in diameter should have a bypass.

#### **4.5.4 Hydrant Design Practices and Standards**

1. Hydrant connections should be six inch diameter except where a four inch diameter main is provided in cul-de-sacs. Where the hydrant is connected to a feeder main of a diameter larger than six inches, or is located on a collector or arterial road, a gate valve should be provided in the connection.
2. Hydrants should be provided so that no part of any house is farther than 500 feet from an accessible hydrant.
3. Hydrants should be the break-away type.

#### **4.5.5 Water Distribution System Materials**

1. Ductile iron pipe is recommended for water mains. However, cast iron, asbestos cement, steel or reinforced concrete can be used if conditions are suitable. Materials, including fittings should be in accordance with the appropriate American Water Works Association (A.W.W.A.) specifications.
2. All cast iron, ductile iron or steel mains should receive an interior cement mortar or coal tar enamel coating meeting the requirements of the appropriate A.W.W.A. standards.
3. Polyvinylchloride pipe or polyethylene pipe meeting the appropriate A.S.T.M. and C.S.A. standards can be considered as alternatives to 1 above, provided that qualified and experienced personnel is available to carry out the installation.
4. Service connection materials should be Type K copper conforming to A.S.T.M. Standard B88 for pipes up to two inches in diameter. The materials used for connections larger than two inches in diameter should be the same as the water main. Polyethylene pipe conforming to C.S.A. standards is an acceptable alternative to copper pipe if qualified and experienced personnel is available to carry out the installation.
5. Hydrants should meet the requirements of A.W.W.A. Standard C-502 and be equipped with two 2½ inch diameter hose connections. Under the proposed standards, pumper connections are not considered necessary in residential areas.
6. All valves in water mains should be gate valves of the solid wedge, double disc type according to A.W.W.A. Standard C-500.

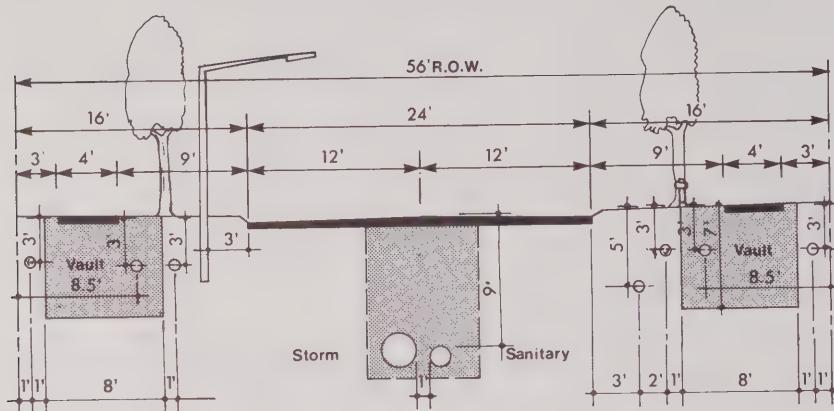
#### **4.6 LOCATION OF SERVICES AND UTILITIES**

It is recommended that the road allowance be adequate to accommodate all services and utilities including:

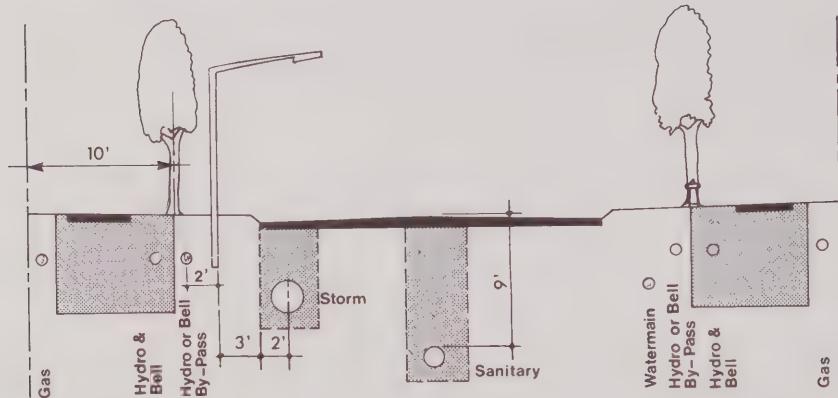
- Roadway,
- Sidewalk(s),
- Sanitary Sewers,
- Storm Sewers,
- Water Distribution Facilities,
- Power,
- Gas/Oil Transmission,
- Telephone,
- Community Antenna Television.

Actual location of each service or utility should be a local decision. However, as a guide, Figure 4.4 presents alternative locations for the narrowest road allowance width recommended. Three options are shown; shallow storm sewer, combined trench storm and sanitary sewers, and water main under the pavement. Each option presents the most constricted situation, namely opposite Hydro and Bell vaults for underground utility location. If overhead utilities are used, these can also be accommodated within the same road allowance. Also shown are possible locations for trees within the road allowance. Trees should be of a size and type consistent with a reduced right-of-way width.

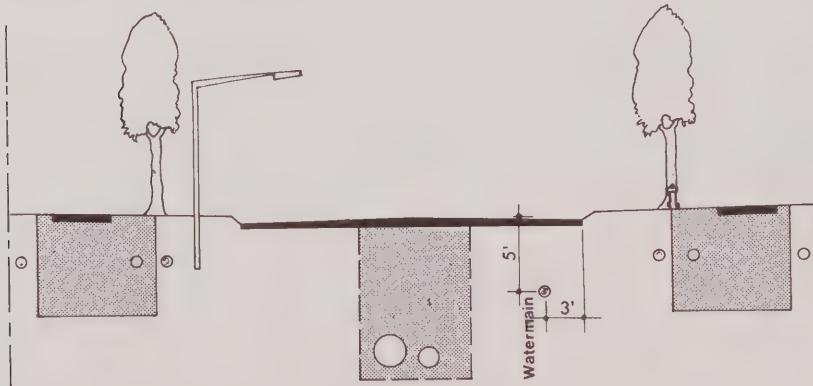
**Figure 4-4 Examples of Alternative Service and Utility Locations within the Road Allowance**



**Common Trench Sewer**



**Shallow Storm Sewer**



**Watermain Under Pavement**

# 5

## Costs and Cost Savings in Residential Servicing



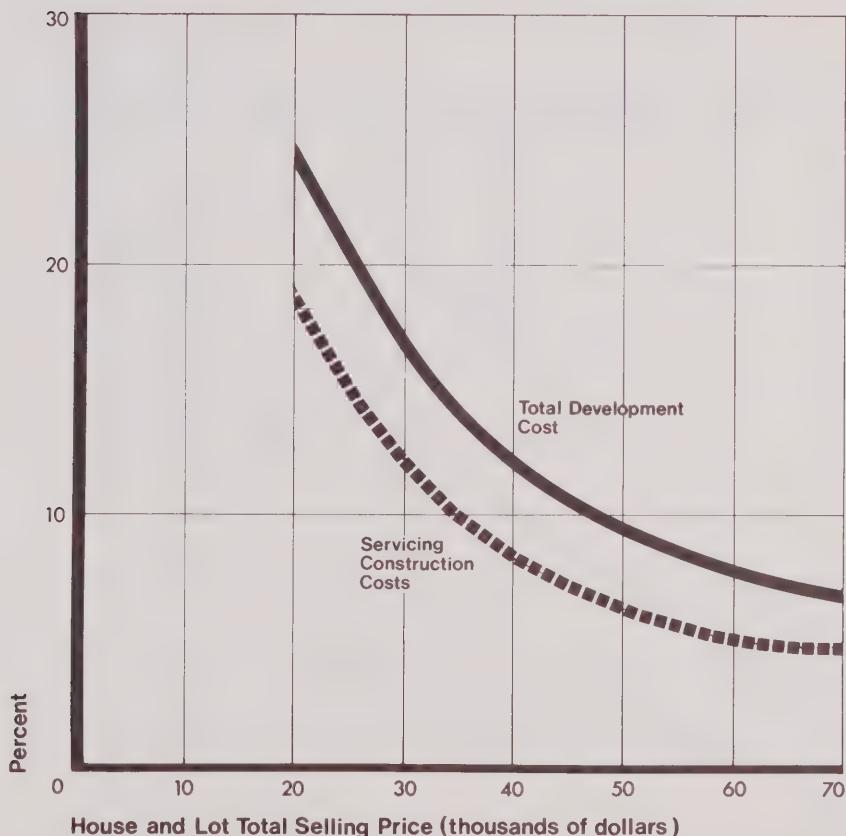
## Costs and Cost Savings in Residential Servicing

5.1

### SERVICING COSTS AS A PERCENTAGE OF HOUSING COSTS<sup>(1)</sup>

Servicing costs constitute a significant part of housing cost. The percentage of the total unit cost varies by location depending on land values, lot size and local construction costs. Figure 5.1 presents the per cent which servicing and development costs at typical urban standards would be of total house cost for a range from \$20,000 to \$70,000, based on 1971-72 cost surveys in several cities in Ontario. This percentage would vary between 24 per cent at a value of \$20,000 to less than 8 per cent at a value of \$70,000. For average house prices in Ontario, the range is between 12 per cent and 15 per cent of the total cost.

**Figure 5-1 Typical Total Development and Services Construction Costs as a Percent of Total House Cost**



Similarly, the servicing cost per house varies with lot size or more specifically with the length of street and related services necessary for a given development. Figure 5.2 presents the variation in development cost with lot frontage for various servicing costs. For the average 1971-72 development cost of \$90. per assessable frontage foot, development cost per lot varies between \$2,600 for a 30 foot lot to \$8,300 for a 90 foot lot.

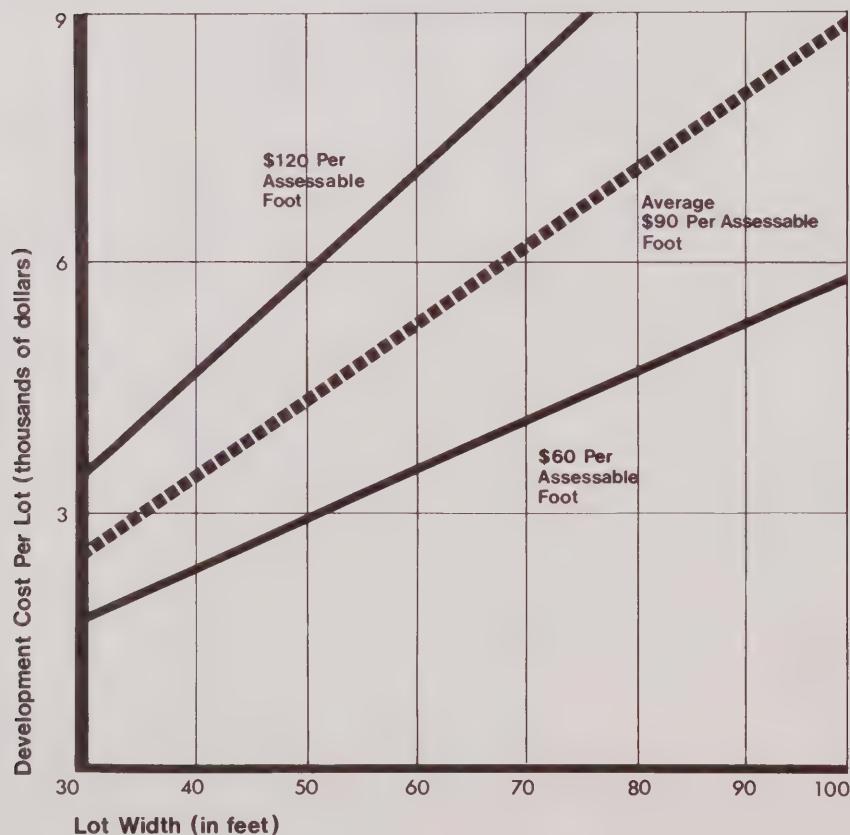
(1) Cost data used in the report were taken from the "Research Report".

TABLE 5.1 – DEVELOPMENT AND SERVICING CONSTRUCTION COSTS

	1971 – 72 Development Cost (\$)	Construction Cost (75% of Dev. Cost) (\$)
Cost per Gross Acre	20,000	15,000
Cost per Lineal Foot of Roads	123	92
Cost per Lot *	4,800	3,600
Cost per Assessable Front Foot	90	68

\* Recent cost information indicates that 1973 development costs per lot may be closer to \$5,500 – \$6,000 per lot with servicing costs approaching \$4,000 per lot.

## Figure 5-2 Development Cost Per Lot Depending on Lot Frontage Width



## 5.2 DEVELOPMENT AND SERVICING COST COMPONENTS

Typical development costs, excluding land or building costs, broken down by components, are shown in Table 5.2. Of the total development cost, approximately 75 per cent is for construction of services. The per cent distribution of these costs is shown in Figure 5.3.

**TABLE 5.2 – BREAKDOWN OF DEVELOPMENT COSTS BY CATEGORY EXCLUDING LAND COST**

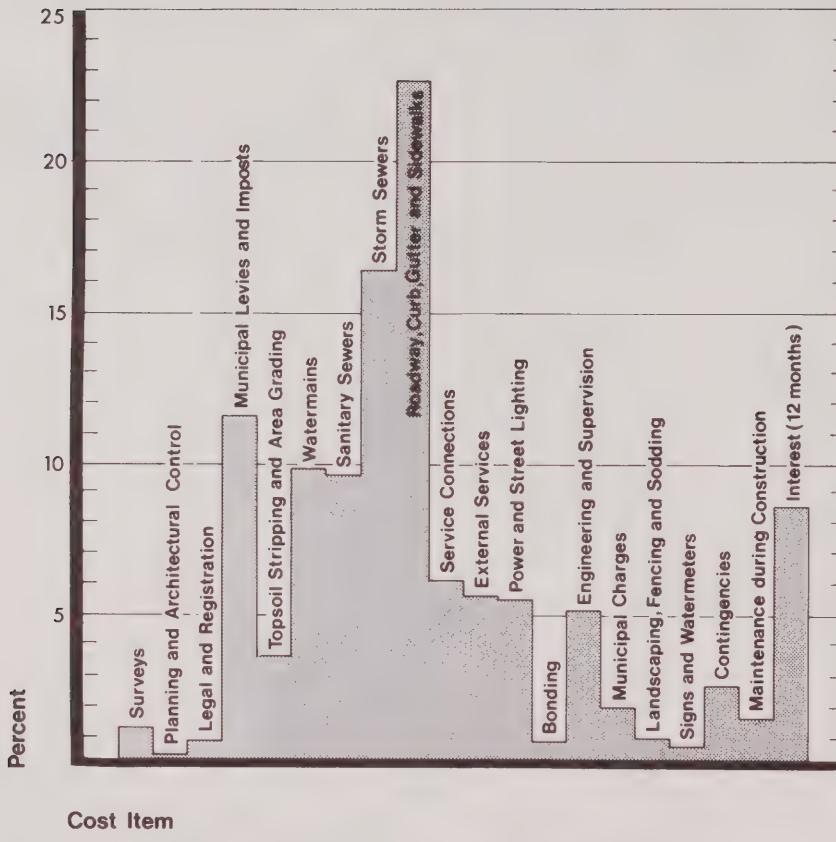
Construction Cost Item	Percent of Total Development Cost	Percent of Construction Cost
Grading	3	4
Water Mains	9	12
Sanitary Sewers	9	12
Storm Sewers	16	22
Roads and Sidewalks	22	29
Service Connections	6	8
External Services & Contingencies	4	5
Engineering	6	8
Sub-Total	75	100
Municipal Charges		
Levies	13	
Power and Lighting	5	
Administration	2	
Sub-Total	20	
Miscellaneous		
Surveying, planning, legal and interest	5	
TOTAL	100	

## 5.3 POTENTIAL CAPITAL COST SAVINGS RESULTING FROM THE RECOMMENDED STANDARDS

Modification of servicing standards to the proposed minimums will not result in large apparent cost savings. In fact, it would appear that the greatest savings can result from permitting greater flexibility in designing for local conditions, such as pavement design by soil testing and permitting a better opportunity for applying new materials and methods which could reduce costs.

Application of the proposed minimum standards, however, could lead to cost savings which although not large, are still significant. Possible savings are summarized in Table 5.3.

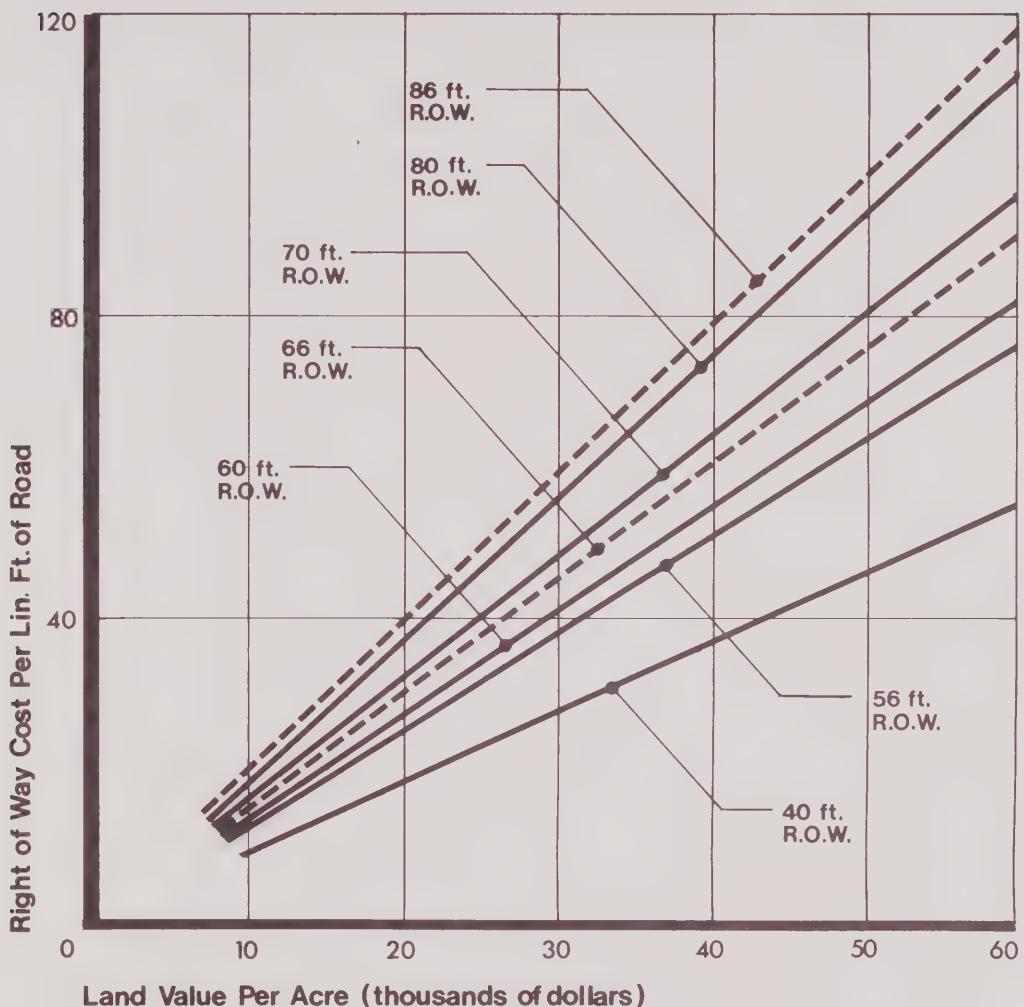
**Figure 5·3 Breakdown of Development Costs as a Per Cent of Total(excluding land cost)**



**TABLE 5.3 – POTENTIAL COST SAVING RESULTING FROM PROPOSED STANDARDS**

	Per Cent Saving
Land for Road Allowance,	(See Figure 5.4)
Sanitary Sewers	up to 5%
Storm Sewers – Shallow System	up to 20%
– Common Trench	up to 5%
Roads	up to 15%
Sidewalks	up to 50%
Water Distribution	up to 20%
Service Connections (See Figure 5.5)	up to 40%
TOTAL APPARENT CAPITAL COST SAVING:	up to 20%

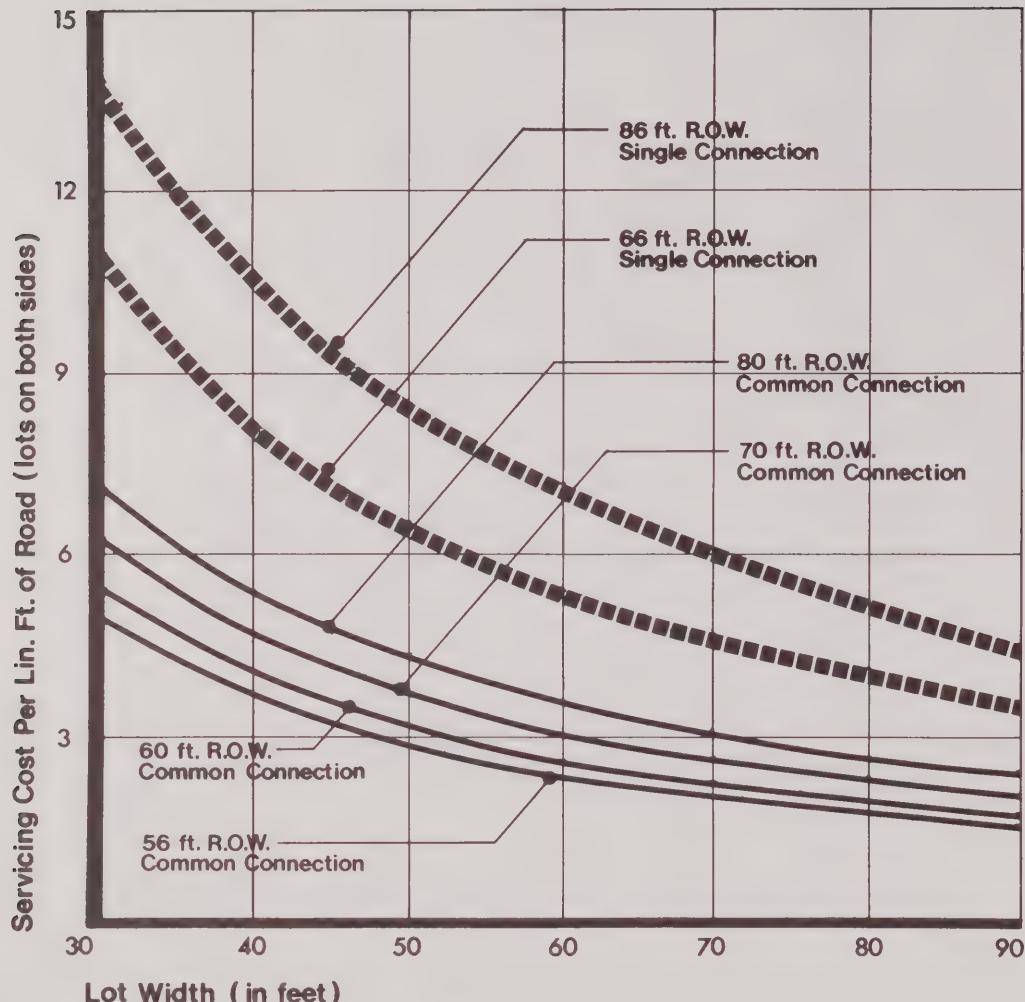
**Figure 5·4 Land Costs and Road Allowance Width**



If, as estimated, the servicing cost per lot is currently about \$4,000, then a potential saving of up to \$800 could be realized in the cost of servicing a home. If right-of-ways are modified to those proposed, an additional savings on land will also be realized. For example, a 56 foot right-of-way compared to a 66 foot right-of-way could save up to \$300 per lot for a 50 foot lot with raw land valued at \$30,000 per acre.

In conclusion, servicing cost savings and increases in lot yield for a given land parcel can be achieved if the proposed minimum standards are applied. The measurable savings in servicing cost can be up to 20% of the total. The measurable saving in land can be up to 5% of the total. The total potential cost saving of over \$1,000, if passed onto the home owner, is not large compared to total house cost. However, the cost saving is significant.

**Figure 5-5 Cost of Service Connections Per Foot of Road**



#### 5.4 INFLUENCE OF STANDARDS ON MAINTENANCE AND ADMINISTRATION COSTS

Reductions in the capital cost of servicing is only effective if the total cost, capital plus maintenance plus administration, is also reduced. For example, reversion to gravel rather than paved roadways could reduce capital cost but would result in substantial increases in maintenance cost.

It was with this in mind that the Committee has proposed the recommended standards. Care was taken to ensure that maintenance costs would not be significantly affected by the proposed standards. Thus with capital, maintenance and administration taken in total, the recommended standards should result in an overall saving in servicing cost.

# 6

## Implementation



# **Implementation**

## **6.1 THE ONTARIO HOUSING ADVISORY COMMITTEE**

The Ontario Housing Advisory Committee recommends that this report be adopted as the recommended guidelines for residential servicing in Ontario. The report should be printed and circulated to all provincial ministries concerned with housing and related services and to all Municipal Administrators and Municipal Engineers, and to Clerks in regions, cities, towns, urbanized or urbanizing counties and townships and municipal engineering consultants in Ontario.

## **6.2 PROVINCIAL AGENCIES**

Use of this report by Provincial departments and agencies should be as a guide to adequate servicing standards for residential development. The recommended standards and practices should not preclude local decisions to provide higher or somewhat different standards where local conditions and/or civic design objectives can be used to justify differences. Where standards differ from current provincial policies, it is recommended that the differences be reviewed with a view to producing uniform guidelines.

In order to encourage innovation and improvements in residential servicing, the Province is encouraged to create incentive for local municipalities to test new practices. The standards recommended in this report should be tested in a case application, monitored and evaluated. Provincial grants and/or subsidies to local municipalities should be considered to permit the testing of the proposed standards and as yet unproven materials, design and construction practices.

## **6.3 LOCAL MUNICIPALITIES**

The standards and practices presented can be used by local municipalities in two ways; first, as a basis for judging residential development servicing designs where local standards are not available, and second, as a measure of comparison of existing local servicing standards against minimum acceptable standards.

It is not intended that the standards presented should serve as a design manual, eliminating local innovation. To the contrary, it is hoped that the guidelines will create the opportunity for greater flexibility in designing for local conditions.

## **6.4 FURTHER RESEARCH**

A number of areas arose as a result of this study which appear to merit further research including:

1. Utility companies are active in co-ordinating locations within the road allowance. Greater effort should be concentrated on the overall co-ordination of the location of all services within the road allowance.
2. Further research into the relationship between storm sewer sizing and costs and selection of design storm and flood protection criteria is required.
3. The Canadian Underwriters Association requirement for fire fighting protection should be re-evaluated in light of current construction standards and fire fighting practices.
4. Legislation which regulates drainage changes by private land owners should be reviewed with a view towards simplifying and strengthening control of changes.
5. The total capital and maintenance cost of open ditch storm drainage versus pipe storm drainage and the conditions under which each is appropriate should be investigated.

# 7

## Acknowledgements



# Acknowledgements

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of the views of the above, their advice and suggestions  
were invaluable.

# 8

Municipal  
Engineering  
Design Formulae



# Municipal Engineering Design Formulae

The following equations are recommended or referred to in the report.

Equation	Variable Description	Unit
<b>Rational Formula</b>		
$Q = CIA$	$Q$ = flow $C$ = runoff coefficient $I$ = rainfall intensity $A$ = area	cfs dimensionless inches/hour acres
$Q = \frac{CIA}{36}$	$Q$ = flow $C$ = runoff coefficient $I$ = rainfall intensity $A$ = area	cubic m/sec dimensionless cm/hour hectares
<b>Headloss Across Manholes</b>		
$H = k \frac{(V2^2 - V1^2)}{2g}$	$H$ = head loss $k$ = coefficient $V1$ = entrance velocity $V2$ = exit velocity $g$ = acceleration due to gravity	feet dimensionless ft/sec ft/sec ft/sec/sec
<b>Catchbasin Inlet Capacity</b>		
$Q = CAV\sqrt{2gH} \times 0.667$	$Q$ = flow $C$ = orifice coefficient = 0.6 for square edged openings = 0.8 for round edged openings $g$ = acceleration due to gravity $H$ = allowable head 0.667 = clogging factor $A$ = area of openings	cfs dimensionless ft/sec/sec ft sq.ft.
<b>Manning Formula</b>		
$V = \frac{1.486}{n} R^{2/3} S^{1/2}$	$V$ = velocity $n$ = Manning roughness coefficient $R$ = hydraulic radius $S$ = hydraulic gradient	ft/sec dimensionless ft feet/foot
$V = \frac{1}{n} R^{2/3} S^{1/2}$	$V$ = velocity $n$ = Manning roughness coefficient $R$ = hydraulic radius $S$ = hydraulic gradient	m/sec dimensionless meters m/m

Equation	Variable Description	Unit
<b>Kutter Formula</b>		
$V = \left[ \frac{1.81}{n} + 41.67 + \frac{0.0028}{Se} \right] \left[ \frac{n}{1 + \sqrt{\frac{R}{n}}} \left( 41.67 + \frac{0.0028}{Se} \right) \right]^{\frac{1}{2}}$	$\sqrt{R Se}$	
	$V$ = velocity $n$ = Kutter roughness coefficient $R$ = hydraulic radius $Se$ = energy gradeline slope	ft/sec dimensionless ft feet/foot
<b>C.U.A. Fire Flow Formula</b>		
$G = 850 \sqrt{P} (1 - 0.01\sqrt{P})$	$G$ = required fire flow $P$ = population	Imperial gpm thousands
<b>Babbitt Peaking Factor</b>		
$K_B = \frac{5}{p^{0.20}}$	$K_B$ = Babbitt peaking factor $P$ = population	dimensionless thousands
<b>Harmon Peaking Factor</b>		
$K_H = 1 + \frac{14}{4 + p^{0.50}}$	$K_H$ = Harmon peaking factor $p$ = population	dimensionless thousands
<b>Hazen-Williams Formula</b>		
$V = 1.32 CR^{0.63} S^{0.54}$	$V$ = velocity $C$ = Hazen-Williams coefficient $R$ = hydraulic radius $S$ = hydraulic gradient	ft/sec dimensionless ft feet/foot
$V = 0.85 CR^{0.63} S^{0.54}$	$V$ = velocity $C$ = Hazen-Williams coefficient $R$ = hydraulic radius $S$ = hydraulic gradient	m/sec dimensionless meters m/m

# 9

## List of Abbreviations



## List of Abbreviations

A.A.D.T.	— average annual daily traffic
A.S.T.M.	— American Society for Testing and Materials
A.W.W.A.	— American Water Works Association
cfs	— cubic feet per second
CL	— centre line
cm	— centimeter
CSA	— Canadian Standards Association
CSPI	— Canadian Steel Pipe Institute
CUA	— Canadian Underwriters' Association
o	— degrees
dia.	— diameter
fps	— feet per second
ft.	— feet
gcd	— gallons per capita per day
gpd	— gallons per day
gpm	— gallons per minute
ID	— inside diameter
m	— meters
min.	— minutes, minimum
mph	— miles per hour
No.	— number
ppa	— persons per acre
psi	— pounds per square inch
R.O.W.	— right-of-way
SIW	— side walk
UDI	— Urban Development Institute
S.S.S.D.	— Safe stopping sight distance
S/W	— side walk
UDI	— Urban Development Institute



# 10

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# List of References

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